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Addressing Gaps in Sustainable Hazardous Waste Management in MSMEs: A Case Study of Motorcycle Repair Shops

Milda Restuti Iriany^a, Ahyahudin Sodri^b, Haruki Agustina^{b,c}

^a Graduate Program of Environmental Science, University of Indonesia, Salemba, Jakarta, 10430, Indonesia

^b School of Environment Science, University of Indonesia, Salemba, Jakarta, 10430, Indonesia

^c Directorate General of Solid Waste, Hazardous Waste and Hazardous Substances Management, Ministry of Environment and Forestry of Republic of Indonesia, 10270, Indonesia

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ABSTRACT

Motorcycle repair shops on the MSME (micro, small, and medium enterprise) scale continue to grow and become an important sector in people's lives. Vehicle maintenance activities in repair shops generate hazardous waste, which needs to be further managed and encouraged to achieve sustainable management. This article analyzes gaps in managing hazardous waste from MSME repair shops in achieving sustainability. This research collected data from 95 repair shop respondents in East Jakarta City, Indonesia. As a complement, the role of hazardous waste management service businesses in managing waste from motorcycle repair shops is also examined based on current management. The collected data was then analyzed descriptively. The research results found that there are gaps that need to be addressed in achieving sustainability, namely the gap in knowledge and attitudes, the gap in behavior (implementation of hazardous waste management), and the gap in the economic value of waste. There is a need for increased knowledge, guidance, and supervision, adjustments to hazardous waste management policies, and the selection of profitable economic instruments. This study is expected to provide input on implementing sustainable hazardous waste management in businesses at the MSME level in Indonesia.

Introduction

MSMEs (micro, small, and medium enterprise) are one of the important pillars of the economy [1], the number of which is increasing every year. According to the ASEAN Investment Report 2022 [2], Indonesia has the highest number of MSMEs in Southeast Asia, with approximately 65.4 million business units. One of the growing MSME sectors in Indonesia is motorcycle repair shops, which has increased with the increase in motorized vehicles. Based on data from the Indonesian Central Bureau of Statistics (*Badan Pusat Statistik / BPS*) for 2020 [3] the number of motor vehicles in Indonesia has grown by 2 to 5% yearly. By 2023, based on data from the Traffic Corps of the Indonesian National Police (*Korps Lalu Lintas Kepolisian Negara Republik Indonesia / Korpantas Polri*), there will be approximately 127 million motorcycle units, 17 million of which are in Jakarta Province. Based on data from the investment and one-stop integrated service office (*Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu / DMPTSP*) of DKI Jakarta Province for 2023, the number of MSME motorcycle repair shops registered in Jakarta Province was quite large, reaching nearly 3,000 units, and it could increase if other repair shops had not been registered. Motorcycle repair shops that perform maintenance activities are categorized as MSMEs based on Presidential Regulation No. 49 of 2021 concerning Amendments to Presidential Regulation No. 10 of 2021 [4].

Based on Government Regulation Number 22 of 2021 concerning the implementation of environmental protection and management [5], there are about 8 types of hazardous waste that can potentially be generated from vehicle maintenance activities in repair shops, namely used lubricating oil (Code B105d), used

Corresponding Author: Milda Restuti Iriany  mildarestuti2704@mail.com  Graduate Program of Environmental Science, University of Indonesia, Salemba, Jakarta, Indonesia.

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batteries (Code B355-2), used hazardous packaging (Code B104d), hazardous contaminated waste (Code A108d) (can be in the form of iron or spare parts contaminated with lubricating oil and others), electronic waste (Code B107d) (can be in the form of cables, used lamps, and others), solvents (Code A355-1), used rags (Code B110d) and paint waste (Code B355-1). Improper management of vehicle waste has the potential to cause pollution, as shown in several countries [6,7] sustainability has not yet been achieved. Sustainability, particularly in sustainable consumption and production, is an effort to address human needs and improve the quality of life while minimizing the use of natural resources and generating waste and emissions [8]. Improving knowledge, awareness, attitude, behavior, and effective resource and waste management are some of the focuses that need to be considered for sustainable consumption and production [9]. Likewise, sustainable hazardous waste management in Indonesia has not been achieved because much hazardous waste from vehicle maintenance activities, whether in households or repair shops, is disposed of in the environment and sold to unlicensed collectors or garbage bins [10–14].

MSMEs experience limited resources, both costs, facilities, technology, and the level of knowledge of managers and workers, so they experience difficulties in environmental management and fulfillment of hazardous waste management requirements according to applicable regulations [15,16]. The existence of local waste managers or local industries can help repair shops to manage hazardous waste [17,18]. Cooperation between repair shops and licensed waste managers can encourage sustainability in hazardous waste management, especially if hazardous waste can be utilized, leading to a circular economy.

This article was prepared to identify gaps in the management of hazardous waste carried out by repair shops, which need to be considered when formulating policies or strategies for sustainable hazardous waste management. East Jakarta City was chosen as the study location because it is one of the cities in Jakarta Province, with the largest number of vehicles and repair shops among other districts / cities. The study results are needed to provide input for making the right policy direction in sustainable hazardous waste management in various MSME-scale businesses, especially motorcycle repair shops.

Materials and Methods

Study Area

The research was conducted in East Jakarta City as the prime location and in the greater Jakarta area as additional locations, including Jakarta, Bogor, Depok, Tangerang, and Bekasi. The research locations are shown in Figure 1. East Jakarta, as the prime location, is the location of the motorcycle repair shop, and the greater Jakarta is the location of the nearest licensed third party (hazardous waste management services). The greater Jakarta was chosen because transportation costs are one of the highest costs incurred in the waste recycling industry when the source is too far away [19,20]. The data were collected between January and March 2024.

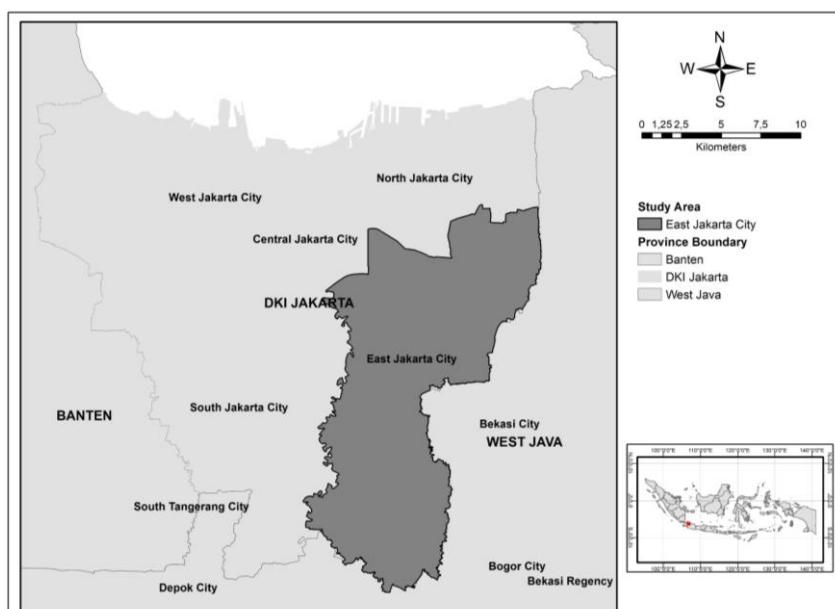


Figure 1. Research location in East Jakarta City.

Collecting Data

The research used a quantitative approach. The research was conducted by collecting quantitative data and then interpreting it using a qualitative descriptive analysis. The number of repair shop respondents in this study was 95, of which 83 were owned by private, family, and individual partnerships, and 12 were repair shops with franchise partnerships, such as *Astra Honda Motor* (AHM) and *Yamaha Motor*. The respondents were workshop managers, represented by workshop owners, technicians, supervisors, or administrators. Repair shop respondents were selected by simple random sampling from the population of motorcycle repair shops located in East Jakarta. In addition, 34 respondents from licensed third parties (hazardous waste management service businesses consisting of hazardous waste collectors, processors / treatment, and utilizers) in the greater Jakarta area were engaged in this research to determine whether they managed hazardous waste from motorcycle repair shops in East Jakarta City. Primary data were collected using questionnaires, interviews, and observations. Secondary data were obtained from the literature and research regulations.

Data Analysis

The data obtained from each respondent are different but related to managing hazardous waste from repair shops in East Jakarta. Three data points were obtained for repair shop respondents: knowledge and attitude level, behavior, and economic value of waste. To measure the level of knowledge and attitude, respondents were given eight statements with five answer options (strongly disagree to agree) using a Likert Scale strongly and were categorized (Table 1). The behavior was assessed by implementing hazardous waste management requirements using a Guttman Scale and percentage and then analyzed descriptively. In addition, the type and amount of hazardous waste generated and the amount handed over to licensed hazardous waste managers (third parties) were identified.

Knowledge and attitude are considered important factors that influence the behavior (implementation) of hazardous waste management [15]. The economic value of waste was assessed by Willingness to Accept (WTA) to measure the trade value of waste and Willingness to Pay (WTP) to measure hazardous waste management service fees by third parties. The WTA and WTP values used the Contingent Valuation Method (CVM) with an open-ended question format [21]. For licensed third parties (hazardous waste management services) respondents, three data were obtained, namely the type of hazardous waste that can be managed according to the permit owned, the amount of hazardous waste that has been managed from MSME repair shops in East Jakarta, the WTA of hazardous waste management service fees, and WTP (considered the 'purchasing value' of waste), which were then analyzed descriptively.

Table 1. Results of the assessment of knowledge and attitude levels based on scores.

Total score	Description
1–8	Respondent does not have knowledge and attitudes about hazardous waste
9–16	Respondent is lacking knowledge and attitudes about hazardous waste
17–24	Respondent has fair knowledge about their knowledge and attitudes about hazardous waste
25–32	Respondent has good knowledge and attitudes about hazardous waste
33–40	Respondent has excellent knowledge and attitudes about hazardous waste

Results

Location Overview

The main research location was East Jakarta City, Jakarta Province. East Jakarta City has an area of 188.03 km² and consists of 10 subdistricts. In 2020, it had a population of 3,275,269 people and a population density of 17,419 people/km², the highest population and population density among other cities and districts. Additionally, based on business licensing authority data obtained from the investment and one-stop integrated service office of DKI Jakarta Province in 2023, East Jakarta has the highest number of motorcycle repair shops, totaling 485 units.

Characteristics of Respondents

Table 2 shows the characteristics of the repair shop respondents in this study. There is no dominating age range; therefore, it can be assumed that work in this repair shop can be done at any age. Although the education level varied, most respondents had a high school education. Of the 34 respondents from hazardous

waste management service businesses, only 22 respondents completed the questionnaire, while 12 respondents did not complete the questionnaire because they had never managed hazardous waste from MSME motorcycle repair shops in East Jakarta. Table 3 shows the types of business activities of the third parties according to their licenses. Fifty percent of the respondents were third parties that conduct hazardous waste collection services, which then hand over the collected hazardous waste to other parties (processors, utilizers, or hoarders) for further management.

Table 2. The number and percentage of motorbike repair shop primary respondents who participated in this research were categorized based on gender and education level.

Characteristic	Number (person)	Percentage (%)
Gender		
Male	87	91.58
Female	8	8.42
Level of Education		
Elementary school	6	6.32
Junior high school	9	9.47
Senior high school	73	76.84
Diploma	4	4.21
Bachelor	3	3.16

Table 3. Number of third-party respondents based on business type.

Type of business (activity)	Number (person)	Percentage (%)
Collection	11	50
Utilization	6	27
Collection + Treatment	1	5
Collection + Utilization	2	9
Collection + Treatment + Utilization	2	9
Total	22	100

Gap in Knowledge and Attitude

Repair shop respondents were asked eight questions to measure their knowledge level and attitude toward hazardous waste management. Respondents were asked three general questions related to their knowledge of environmental and waste management responsibilities and five specific questions related to their knowledge of hazardous waste, hazardous waste management, and the underlying regulations. Table 4 presents the knowledge and attitude gaps between privately owned and franchised repair shops.

Table 4. Categorization of the level of knowledge and attitudes of workshop managers (respondents) based on the average score in the group of privately owned repair shops and franchise-partnered repair shops.

Variables	Score		Category
	Range	Average	
Level of Knowledge			
Privately owned repair shops (inc. family owned and individual partnerships)	17–25	18.9 (General questions: 12.2 Specific questions of HW: 6.7)	Fair
Repair shop with franchise partnership (authorized service station)	22–31	25 (General questions: 13.8 Specific questions of HW: 11.2)	Good
Level of Attitude			
Privately owned repair shops	16–26	19.9	Fair
Repair shop with franchise partnership	20–30	24.7	Good

The knowledge level is sufficient, as most respondents know they are responsible for a healthy environment and hazardous waste management. However, answers to specific questions about hazardous waste had very low scores. This indicates that most respondents did not know about hazardous waste or its management. A gap exists in the differences in repair shop ownership. Although they do not show very good knowledge, repair shops with franchise partnerships have slightly better management knowledge. This is because of regular training for managers, including waste management training. Respondents from privately owned repair shops stated that they had never received socialization related to hazardous waste management and were not aware of the regulations governing it.

Similar to the level of knowledge, attitude also shows a gap in repair shop ownership. However, there is not a significant difference; repair shops with franchise partnerships have slightly better management attitudes. In general, all repair shops manage hazardous waste based on economic value and are not based on applicable regulations. Hazardous waste that can still be sold is collected and stored, while other waste is disposed of in trash or waterways. This occurs in many other cities in Indonesia, potentially degrading the environmental quality [10–13].

Mandra et al. [15], state that the gap in the education and attitudes of repair shop managers is particularly evident in repair shops that maintain traditional management methods, including how they manage waste. Lack of knowledge affects the attitude of repair shop managers, ranging from less effective and efficient operations to waste management that does not concern environmental hygiene and health. Improvements in education, both formally and informally (e.g., training, socialization, etc.), may foster awareness to improve attitudes toward workshop operations and waste management.

Gap in Behavior

The behavior of repair shop respondents in managing hazardous waste was measured based on the fulfillment of 27 compiled questions that met the requirements of hazardous waste management activities. The questions were compiled based on Government Regulation Number 22 of 2021 and the Regulation of the Minister of Environment and Forestry Number 6 of 2021 concerning the procedures and requirements for hazardous waste management. The questions are divided into five sub-variables: identification and sorting (two statements), packaging (six statements), storage (13 statements), recording and reporting (four statements), and handling hazardous waste to a licensed third party (two statements). Table 5 shows the gaps in compliance with hazardous waste management.

Table 5. Level of hazardous waste management compliance.

Ownership	Score of compliance		Percentage of compliance (%)	
	Range	Average	Range	Average
Privately owned repair shops	6–14	10	22–51	36.4
Repair shop with a franchise partnership	13–20	16	48–74	57.4

The gap in the fulfillment of hazardous waste management requirements measured as repair shop behavior is very clear among repair shop owners, as shown in the knowledge and attitude levels. The presence of guidance or training from an authorized service center as a franchisor is quite influential in hazardous waste management behavior. Nevertheless, all repair shops indicated that they still disposed of hazardous waste in the trash. Figure 2 shows typical repair shop conditions based on repair shop ownership.

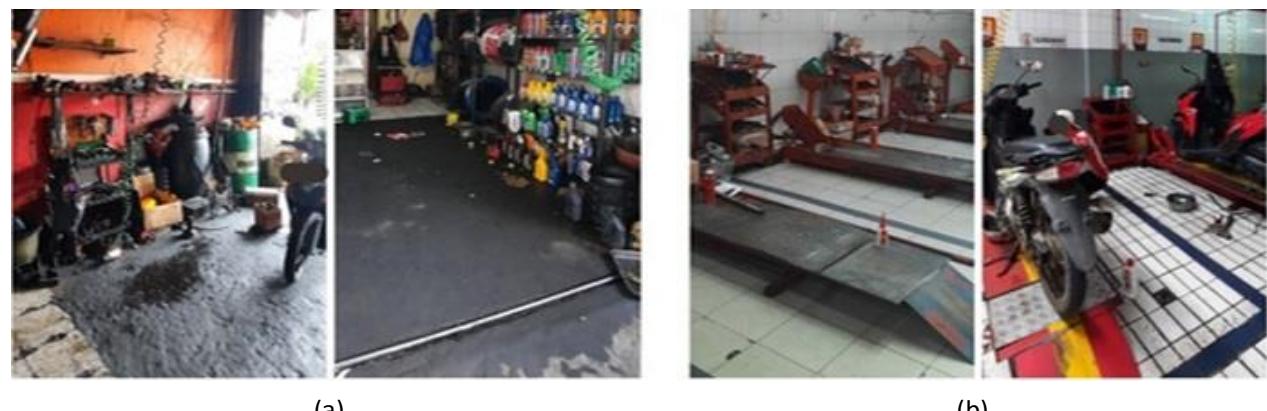


Figure 2. Typical repair shop conditions: (a) privately owned repair shops; (b) repair shops with franchise partnerships.

Only one of the 95 repair shops could properly identify and segregate hazardous waste, as shown in Figure 3. In contrast, others were segregated based on the economic value of hazardous waste. Likewise, hazardous waste packaging is only done based on economic value, and some packaging is in poor condition. Seven respondents provided temporary storage for hazardous waste, which was also unfit, as shown in Figure 4. None of the respondents conducted hazardous waste recording or reporting to an authorized agency. Some

respondents stated that they once handed over hazardous waste, such as lubricating oil, to a licensed third party, but no longer because the price offered by unlicensed collectors is usually higher.

In addition, the lack of supervision from authorized institutions, such as local governments, encourages disobedience in hazardous waste management. One repair shop manager stated that a few years previously, they handed over hazardous waste to licensed hazardous waste management services owing to the local government's intense monitoring and supervision. However, when such monitoring and supervision were not enforced, they returned to handing over waste to unlicensed collectors.



Figure 3. Examples of proper identification and segregation.



Figure 4. Examples of inappropriate temporary storage for hazardous waste.

Based on the results of the data analysis, repair shop respondents have the potential to generate seven hazardous wastes: used lubricating oil, used batteries, hazardous packaging, hazardous contaminated waste (in the form of iron or spare parts contaminated with lubricating oil and others), electronic waste, solvents, and used rags. Two of the respondents also generated paint waste. In contrast, the other repair shops did not generate any, as they did not provide painting services. However, not all amounts of hazardous waste can be identified, as some hazardous waste, such as solvents, paint waste, and mop, are disposed of in trash or waterways. The questionnaire results also showed that the respondents of hazardous waste management service businesses in greater Jakarta were licensed to manage their hazardous waste. However, it varies according to license.

Unfortunately, the results of the data analysis show that the most hazardous waste from motorcycle repair shops in East Jakarta is not managed by a licensed third party (hazardous waste management services). Only five of 34 licensed third-party respondents have managed hazardous waste from motorcycle repair shops in East Jakarta. Based on data from 95 repair shops, there is a considerable gap in the amount of hazardous waste generated by repair shops and managed by licensed third parties in a month, as shown in Table 6. Although some hazardous waste appeared to have been managed in higher quantities, 95 respondents stated that they did not hand over hazardous waste to licensed managers. Hence, the managed waste came from repair shops other than the 95 respondents in this study, which requires further assessment. This gap could be even larger if all the repair shops in East Jakarta were calculated.

This gap occurs for two reasons: based on questionnaires to licensed third parties and interviews with two recycling companies. First, there is a price gap; therefore, repair shops prefer to sell waste to unlicensed third parties who offer higher prices (as discussed previously). Licensed third parties cannot provide the desired price because hazardous waste management incurs considerable operational costs. Second, there is an electronic recording and reporting system for transferring hazardous waste owned by the Ministry of

Environment and Forestry. Simultaneously, repair shops are not yet registered in the system. This causes third parties to be unwilling to manage hazardous waste from MSME motorcycle repair shops because they are trying to comply with the applicable regulations.

Table 6. Gap between the amount of hazardous waste (generated and managed).

Type of hazardous waste	Generated by 95 motorcycle repair shops	Managed by a licensed third party (hazardous waste management services)
Waste lubricating oil (liter)	14,365	9,200
Used battery (pcs)	672	0
Used packaging (kg)	358.5	200
Contaminated waste (kg)	1,755	0
Electronic waste (kg)	54.75	100
Used rags (kg)	27	100
Solvent (liter)	1.8	0
paint waste (liter)	0	0

Gap in The Economic Value of Waste

Several studies have shown that economic motives are one of the drivers in conducting waste management, especially for waste that can still be recycled economically [22–24]. Likewise, the management of hazardous waste from motorcycle repair shops is heavily influenced by the trade value of the waste. Two gaps in the waste economy were identified, as listed in table 7. First, the trade value of waste is still considered useful by repair shops, and licensed third parties are still quite distant. This is because of the operational costs of managing hazardous waste. Second, the cost of hazardous waste management services, particularly hazardous waste, is considered useless. The repair shop is unwilling to pay the management fee, while the third party still asks for it. This needs to be addressed to achieve sustainable hazardous waste management.

Table 7. The gap between WTA and WTP.

Value of waste	Waste lubricating oil (per liter)	Used battery (per pcs)	Used packaging (per kg)	Contaminated waste (per kg)	Electronic waste (per kg)	Used rags (per kg)	Solvent (per liter)	Paint waste (per liter)
Sale - purchase value of waste								
WTA Motorcycle repair shops (IDR)	2,305	15,797	3,146	4,006	1,875	0	0	0
WTP Licensed third party (IDR)	1,212	5,125	1,000	1,500	1,250	1,500	1,750	1,750
Waste management service fees								
WTP Motorcycle repair shops (IDR)	0	0	0	0	0	0	0	0
WTA Licensed third party (IDR)	1,694	4,916	3,033	2,743	4,350	3,062	3,041	4,050

This gap between WTA and WTP is certainly a threat to the sustainability of hazardous waste management. Even in East Jakarta, the illegal trade of hazardous waste to unlicensed third parties occurs in many other cities [10,13,25]. In most cases, these unlicensed third parties offer a higher price because they do not perform proper management; thus, their operational costs are low. In contrast, licensed third parties incur operational costs for their management, such as the use of technology, environmental monitoring, worker safety, etc. Strict supervision and law enforcement should be encouraged to restrict the movement of unlicensed third parties. Licensed third parties may combine economic instruments related to hazardous waste, such as making collective packages for the type of hazardous waste to be collected and managed and hazardous waste with a beneficial value. Increasing knowledge and awareness of the potential harmfulness of hazardous waste is necessary; however, economic motives may also encourage repair shop managers to collect and store hazardous waste more properly. As stated in a previous study, economic incentives play a significant role, although not the only factor, in the success of recycling, including in encouraging waste collection and segregation [26]. Furthermore, the cost of hazardous waste management may increase the cost of vehicle maintenance services, which in turn affects the preference of vehicle owners to choose a repair shop [27], thereby reducing the repair shop's revenue.

Discussion

MSME motorcycle repair shops face significant challenges in terms of environmental management. Many limitations are experienced by MSMEs, such as limited resources, costs, facilities, technology, and the level of knowledge related to hazardous waste by managers and workers, yet they are required to fulfill the application of the same rules and policies as larger companies that have more qualified resources [14–16]. Presently, regulations concerning hazardous waste management also do not provide exemptions to the requirements for MSMEs, so achieving proper compliance with the regulations may be difficult. The reassessment of hazardous waste management requirements may be reconsidered and adjusted according to the business level. The regulation of hazardous waste management may be simplified for business activities that only produce a very small amount of hazardous waste, such as at the MSME level. In the USA, for example, the government simplifies the management of hazardous waste for businesses that produce less than 100 kg/month of hazardous waste [28]. The company must only identify and store according to the time and storage limits and hand it over to a licensed third party. It does not require an identification number (registered) from the local authority. This may be considered in hazardous waste management policies for MSMEs in Indonesia.

The existence of licensed third parties is very important in assisting hazardous waste management due to various repair shop limitations [18]. Sustainable hazardous waste management can create a circular economy of sustainable production and consumption [9,18]. The transition to sustainable waste management through reuse reduction, and numerous countries have performed recycling [29,30], including the possibility of the concept of utilizing waste in energy sources [31]. Likewise, the role of two recycling companies is crucial for sustainability. Recycle activities can close the open loop (waste is discharged into the environment) by reintroducing the waste as an input in the production line that provides benefits for multiple dimensions [32]. Recycling used lubricating oil and used batteries can reduce dependence on and exploitation of natural resources, although selecting the proper technology must also be considered [6,33–35]. However, the two companies have not reached 50% of their production capacity until now due to the difficulty of raw materials (hazardous waste), which is thought to be widely used by unlicensed third parties. Figure 5 shows the current condition of hazardous waste management from motorcycle repair shops, which does not show sustainability.

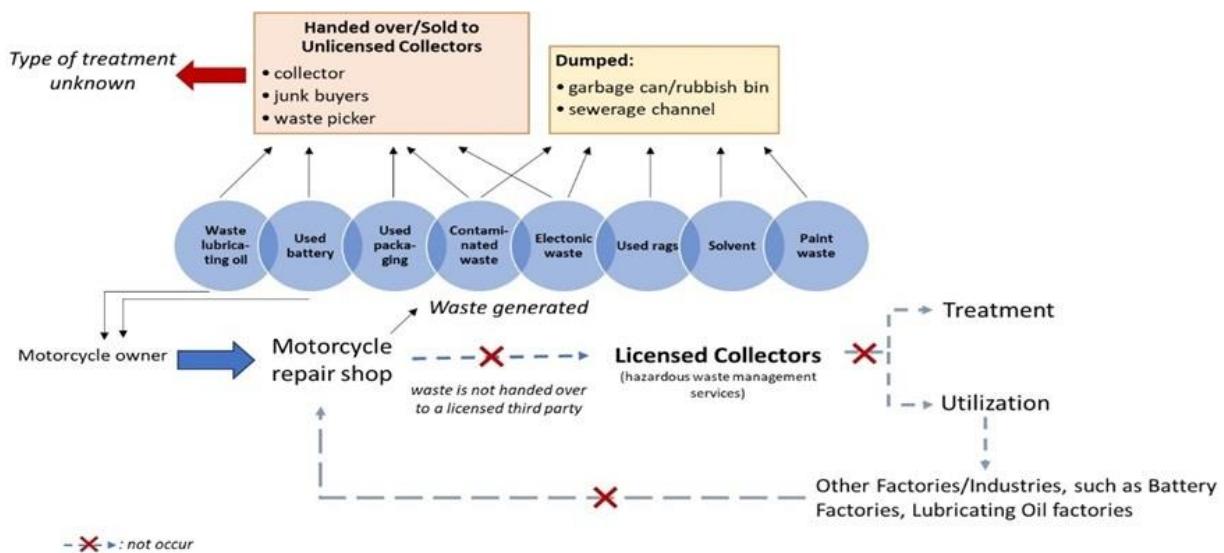


Figure 5. Unsustainable hazardous waste management by motorcycle repair shop.

In its current state, sustainability is not achievable due to the large amount of hazardous waste that goes to unlicensed third parties. One option that needs to be seriously considered is to provide assistance and guidance and encourage them to become a formal part of the sustainability system, as Tröger et al. [36] and Rojas et al. [37] have proposed. All stakeholders strongly require collaboration, including repair shop managers, local government, central government, hazardous waste management service businesses, the recycling industry, advanced industry, and others, to achieve the sustainability of hazardous waste management. Collaboration by all stakeholders is important for achieving sustainability, so each of them must recognize their role and contribution to sustainability [1,38–40].

Conclusions

Sustainable hazardous waste management benefits the environment, and the social framework of stakeholder cooperation is economically beneficial. It is important to understand the gaps and challenges that exist. Some gaps occur in repair shop knowledge and attitudes, behaviors (implementation of hazardous waste management and amount of appropriately managed hazardous waste), and the economic value of waste. There is a gap in knowledge, attitudes, and behaviors between privately owned and franchised repair shops owing to the absence of standard procedures and training related to hazardous waste management in privately owned repair shops. This includes a behavioral gap regarding hazardous waste management, in which nearly all such waste is handled by unlicensed third parties. Additionally, there is an economic gap in waste valuation, as the bid prices (purchase value) offered by licensed hazardous waste management services are significantly lower than what the repair shops are willing to accept, coupled with reluctance on the part of the repair shops to pay for hazardous waste management services. To overcome this, it is necessary to increase knowledge and guidance for repair shop managers, especially in hazardous waste management, strict supervision by unlicensed third parties, adjustment of hazardous waste management policies for the MSME sector so that licensed third parties can manage it, and selection of appropriate economic instruments that are profitable for both parties. Sustainable hazardous waste management can be achieved by addressing these gaps.

Author Contributions

MRI: Conceptualization, Methodology, Writing - Review & Editing; **AS**: Conceptualization, Writing - Review & Editing, Supervision; **HA** Conceptualization, Writing - Review & Editing, Supervision.

Conflicts of Interest

There are no conflicts to declare.

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